Use of Fish Transportation Barge for Increasing Returns of Steelhead Imprinted for Homing

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USE OF A FISH TRANSPORTATION BARGE FOR INCREASING RETURNS OF STEELHEAD IMPRINTED FOR HOMING, 1983

by
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and

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ABSTRACT

In 1982, the National Marine Fisheries Service, under contract to the Bonneville Power Administration, began a S-year study (Project 82-2) to determine If transporting steelhead, Salmo gairdneri, smolts by barge from Dworshak National Fish Hatchery to a release site in the Columbia River below Bonneville Dam would result in increased returns of adults to the fishery and hatchery. Eight separately identifiable groups of about 30,000 steelhead each. were marked *and* released in 1982. The study continued in 1983.

During 1983, over 251,000 smolts were marked--about 30,000 fish for each of four test lots (barged) and four control lots (released into the Clearwater River near the hatchery). Serial releases of test fish in 1983 were made on 20 April and 3 and 24 May. Paired control groups were released on 20 April, and 3 and 25 May.

The health and **status** of smoltification of the juvenile fish were monitored from March to the release date for each group. The fish sampled were considered to be in good health and well advanced in smoltification at release.

Fish from the control releases were 'recovered at dams and in the estuary along their migration route. Approximately 29% of the fish from the control releases were transported from collector dams (Lower Granite, Little Goose, and McNary) as part of the routine transportation program.

The relatively large number of l-ocean age adult steelhead (179) recovered at adult collector dams (Lower Granite, McNary, and Bonneville)

and in the Indian fishery (Columbia River Zone 6) indicates a high survival of steelhead released as smolts in the spring of 1982. A large return of 2-ocean age adults is expected in 1984.

Final evaluation of the study will be based on the number of adults returning in ensuing years to the Columbia River fisheries; adult collector points at Bonneville, McNary, and Lower Granite Dams; fisheries in Idaho; and the Dworshak National Fish Hatchery homing site.

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INTRODUCTION

In 1982, the National' Marine Fisheries Service (NMFS) began 'a 5-year study (Project 82-2) under contract to the' Bonneville Power Admitiistration (BPA) to determine if transporting steelhead, Salmo gairdneri, smolts by barge directly from Dworshak National Fish Hatchery (NFH) to the 'Columbia River below Bonneville Dam would increase the return of adults to the fishery and hatchery (Harmon and Slatick 1983);

The primary objectives of. this study are as follows:

1. Determine if steelhead reared and imprinted at Dworshak NFH and transported by truck to a transfer site near Lewiston, Idaho; transferred into a barge; and transported to a release site in the Columbia River below Bonneville Dam and released will return as adults to' the hatchery and to the fishery in Idaho in greater numbers than fish released directly into the river at the hatchery.

2. Determine the proportion of fish in each test release that have accepted a homing imprint.

3. Determine the relationship between the physiological condition of steelhead and their ability to imprint.

During 1982, eight separately identifiable groups of about' 30,000 steelhead each were marked and released. The study continued in 1983, and specific activities included 'marking 'and releasing eight groups of: juvenile steelhead, determining health profiles and monitoring smoltification of experimental groups, and monitoring recoveries of marked 'juvenile and adult steelhead at dams and lower river recovery sites on the Columbia and Snake Rivers. This report summarizes activities in 1983.

PROCEDURES

During our second year of marking,. eight separate groups of steelhead (~30,000/group) were tagged, (Table 1). Marked fish were from eight ponds in System II (a reuse water system) at Dworshak NFH. All fish from these ponds were progeny of fish spawned during a 2-week period in the spring of 1982 (Egg Takes 5 and 6).

From 17 January to 3 February 1983, 251,491 steelhead were marked with an adipose fin excision and injection, of a magnetic coded wire tag (CWT). The fish were also externally marked with a thermal brand so their progress could, be monitored at key sampling sites along their migration route without sacrificing the fish.

The general health and status of smoltification of each experimental group were monitored from March until they were released from the hatchery or transported by barge. This portion of the project was carried out under subcontract to the U.S. Fish and Wildlife Service, Ahsahka, Idaho.

Prior to 1981, the normal hatchery production smolt releases were pumped from the hatchery via a pipe and released into the North Fork of the Clearwater River. In 1981, approximately 50% of the hatchery production was pumped to the North Fork while the other 50% was released by gravity flow to the mainstem of the Clearwater River. After 1981, all normal hatchery production was released by gravity flow to the mainstem of the Clearwater River.

Due to the low number of l-ocean age steelhead that returned to Dworshak NFH in the spring of 1983 (from 1981 smolt releases), there has been some concern that some of the fish released in the mainstem may have bypassed the hatchery and strayed upstream. With this in mind, we felt

Table 1.--Steelhead marked in 1983 at Dworshak National Fish Hatchery.

Test number	Coded wire tag code	Brand	Marked fish released	Unmarked fish released	Date released from hatchery	Treatment
Control (Cl)	23-16-38	LAW-1	33,178	113	4-20-83	Released as normal hatchery production into the mainstem Clearwater River.
Test (T1)	23-16-40	RAF-1	30,341	165	4-20-83	Trucked directly from hatchery to Clearwater River near Lewiston, ID; held in barge for approx. 16 h; and barged for release below Bonneville Dam.
Test (TIA)	23-16-39	RAZ-1	~28,658	1 3 3	4-20-83	Pumped to another pond and held for 7 days; then trucked directly from the hatchery to Clearwater River near Lewiston, ID; held in barge approx. 16 h; and barged for release below Bonneville Dam.
Control (C2)	23-16-16	LAW-2	32,236	8,128	5-3-83	Released as normal hatchery prod&ion into the mainstem Clearwater River.
Control	23-16-19	RAF-3:	31,956	1,378	5-3-83	Released (pumped) as normal hatchery production into the North Fork Clearwater River. -
Test (T2)	23-16-17	RAP-2	32,456	2,242	5-3-83	Truck directly from hatchery to Clearwater River near Lewiston, ID; held in barge for approx. 16 h; and barged for release below Bonneville Dam.
Control (C3)	23-16-20	RAF-4	30,751	219	5-25-83	Released as normal hatchery production into the mainstem Clearwater River.
Test (T3)	23-16-18	LAW-3	31,906	2,703	5-24-83	Trucked directly from hatchery to Clearwater River near Lewiston, ID; held in barge for approx. 16 h; and barged for release below Bonneville Dam.
		TOTAL	251,491	15,081		

that it would be beneficial to take one of our originally scheduled barged groups of marked fish and pump them to the North Fork as a second control group in the second serial release (a control group was also released into the mainstem of the Clearwater River). This change was made after consultation with our statistician (to assure that the change in the experimental design would not affect the validity of the experiment), appropriate fisheries agencies, and BPA. Reducing the number of serial releases from four to three resulted in slightly longer intervals between releases to bracket the original time frame. The actual release dates were 20 April and 3 and 24 May. Paired control groups were released on 20 April and 3 and 25 May (Table 1).

All test and control groups were reared on reuse water in System II at 46°F. On 6 April 1983, the water was changed from reuse to raw North Fork Clearwater' River water at 40°F. Fish from Test TIA were pumped to another pond in System II on 13 April 1983 and held for 7 days before being transported. This treatment was required to duplicate the successful test treatment in the 1978 Dworshak NFH experiment (Slatick et al. 1982).

Test groups were loaded directly into fish transport trucks via fish pumps and transported to Lewiston, Idaho, on the Clearwater River (approximately 40 miles downstream) where they were off-loaded into a fish transport barge and held in recirculated Clearwater River water for approximately 16 h. The barge then traveled downstream with stops at Lower Granite, Little Goose, and McNary Dams to load fish as part of the transport program operated by the U.S Army Corps of Engineers (CofE) (Figure 1) (Delarm et al. 1984). Fish were released during darkness into the Columbia River below Bonneville Dam at Skamania Light (RM 140).

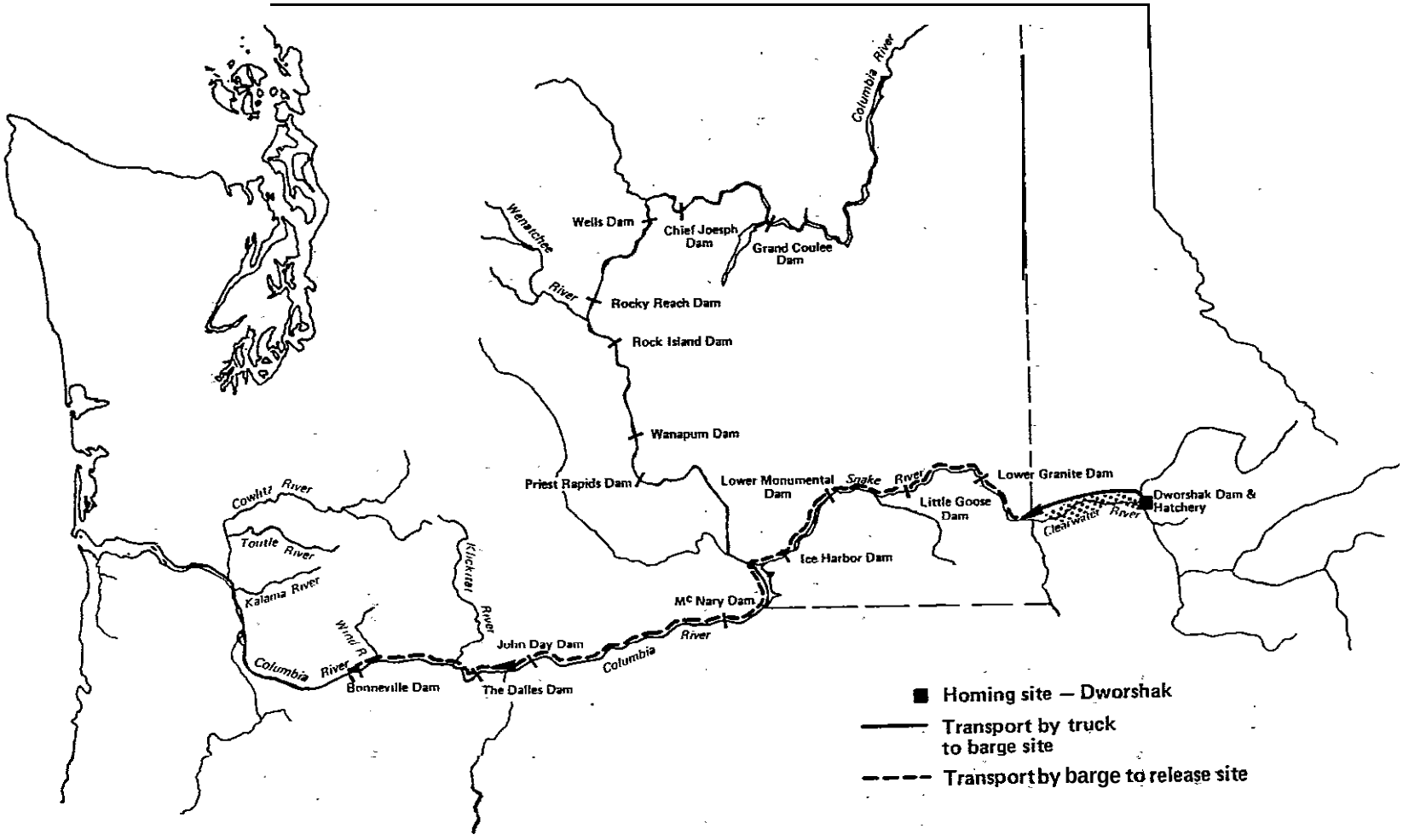

Figure 1.--Study area germane to the 1983 homing experiment with steelhead from Dworshak National Fish Hatchery.

Adults from the 1982 release ware sampled at in-river sampling sites (Bonneville, McNary, and Lower Granite Dams and the Zone 6 fishery. At dams, adult collectors constructed in the fishways intercepted wire tagged adults without sacrificing the fish. These collectors generally consisted of a denil fishladder, which migrating adults ascended, and a tag detection system that separated fish with CWTs into a trap and returned untagged fish to the fishway. The trapped fish were examined, and those that were branded were identified, jaw tagged, and released to continue their upstream migration (Ebel et al. 1973).

Evaluation ‘will he based on percentage return and test to control ratios (T/C ratios) at the in-river sampling sites, sport and commercial fisheries, and the hatchery. Percentage return will be used as the main indicator of survival enhancement or transport benefit rather than T/C ratios. It is difficult to assess transport’ benefit from T/C ratios because so many control fish are also transported ‘around dams. Although differences in T/C ratios at dams, in fisheries, and back at hatcheries provide the means to assess the degree of homing impairment resulting from the direct transport from Dworshak NFH. When adult returns are complete, a discrete multivariate analysis will be used to statistically compare test and control treatments at the various sites (Bishop et al. 1975). In this procedure, the treatments are structured as contingency tables, and significance is determined by the chi-square statistic.

Information each year on numbers of control fish transported from dams, numbers of true controls (those not transported that migrated downriver through the dam complex) as determined by their estimated passage at John Day Dam, and numbers of test and control fish captured at Jones

Beach provide the needed data for correctly interpreting transport benefits on returning adults--see Adult Returns section for example.

RESULTS

Recapture of Smolts at Dams and in the Estuary

Juveniles from control groups released at the hatchery were monitored at Lower Granite, McNary, and John Day Dams to determine the number of control fish that were either transported in the CofE operation or migrated downriver on their own volition (true controls). Overall, 37,244 (29.1%) fish from the control releases were transported from Lower Granite, Little Goose, and McNary Dams and 13,477 (14.8%) of the true controls survived. to John Day Dam (Table 2). In 1982, 57% of the fish from the control releases were transported, but only 6.1% of the. true controls survived to John. Day Dam (Harmon et al. 1983). Overall, the number of fish from control releases estimated to have reached the lower river in each year was comparable--50,721 in 1983 and 55,493 in 1982.

A summary of recoveries from estuary sampling (Jones Beach, Oregon) is presented in Table 3. Dawley et al. (1984) indicated that recoveries of fish from test and control releases were highest from the later releases. On our last release (24 and 25 May 1983) recoveries were substantially higher on the test (barged) group than on the control group, whereas recovery of test and controls were similar from the first and second paired releases.

Juvenile Fish Health and Smoltification

Investigators from the U.S. Fish and Wildlife Service concluded from data based on physical, physiological, and histological observations that

Table 2.--Estimated number of marked steelhead from control releases at Dworshak National Fish Hatchery that were either transported or migrated downriver on their own volition (true controls) and survived to John Day Dam (Sims et al. 1983).

Control no.	Tag code	Number released (A)	Collected and transported a/		Survival of true controls to John Day Dam	
			No. (B)	%(B) (A)	No. (C)	%(C) (A-B)
C-l	23-16-38	33,178	9,304	28.0	5,864	24.6
c-2	23-16-16	32,236	8,181	25.4	2,155	9.0
C-2A	23-16-19	31,956	9,719	30.4	1,716	7.7
c-3	23-16-20	30,751	10,040	32.6	3,742	18.1
Combined	-	128,121	37,244	29.1	13,477	14.8

a/ Transported from Lower Granite, Little Goose, and McNary Dams to release site in Columbia River below Bonneville Dam.

Table 3.--Marked steelhead 'from Dworshak National Fish Hatchery that were recovered at Jones Beach, Oregon, on the Columbia River in 1983.

Test number	Coded wire tag code	No. fish recover.&	% recapture of juveniles released	Date of median recapture
Control (Cl)	23-16-38	68	0.205	5-15-83
Test (Tl)	23-16-40	76	0.250	4-25-83,
Test (T1A)	23-16-39	56	0.195	4-25-83
Control, (C2)	23-16-16	88	0.273	5-18-83
Control (C2A)	23-16-19	95	0.297	5-21-83
Test (t2)	23-16-17	100	0.308,	5-7-83
Control (C3).	23-16-20	142	0.462	6-5-83
Test (T3)	23-16-18	249	0.780	5-28-83

a/ Numbers adjusted for catch effort.

the fish in all groups were, in good health and well advanced in smoltification at time of release.' 'The major difference between groups was a higher incidence of gill and nasal epithelial hyperplasia of fish examined from late April to early May. Fish examined in mid to late May were normal. In early April, hatchery management switched from reuse water to raw water with a reduced temperature; this may have aided in the' repair of the damaged tissue.

Gill Na^+-K^+ ATPase activity increased during the monitoring period from 2 March to 24 May 1983 (Figure 2). The last control group (C3) 'was used as a baseline for comparison with other control and test' releases. Analysis of variance with significance established at ($P<O.O5$) was used for statistical comparisons. Release Groups TlA, C2,' C2A, and T3 showed no significant differences from the baseline level. Levels for Groups Cl and T2 were significantly lower, and the level from Group T1 was significantly higher than baseline levels.

Although statistical tests in three groups showed deviation from baseline Na^+-K^+ ATPase levels, we are not concerned at this time. Releases of all control and test groups occurred during the period of high Na^+-K^+ ATPase activity--within the range expected at Dworshak NFH. Direct observation and analyses conducted by the physiologist and hatchery pathologist lead us to believe that all groups were well smolted. The complete report on fish health and smoltification is presented in Appendix A.

Adult Returns

One-ocean age adult returns from smolts released in the spring of 1982 were monitored in the Indian fishery on the Columbia River and at the

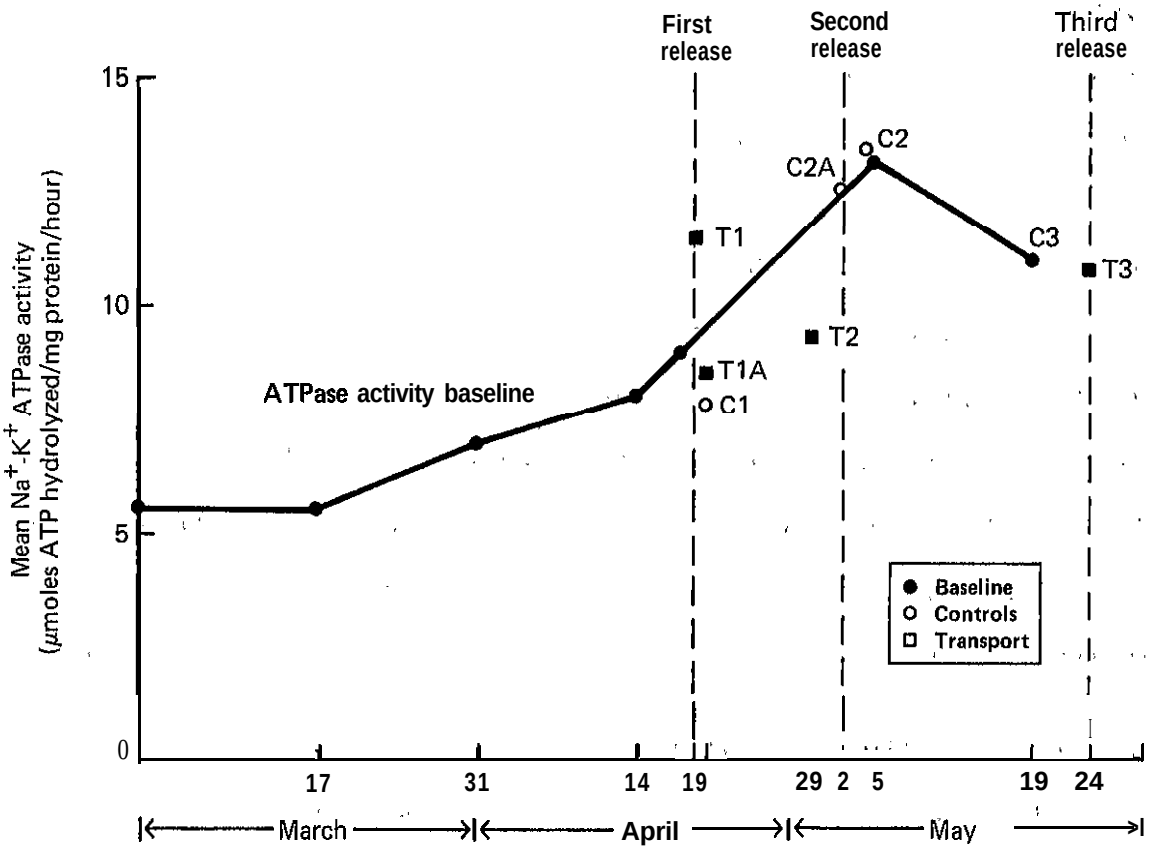

Figure 2.--Na+K+ ATPase activity for steelhead test fish reared at Dworshak NFH and released in 1983." Control group (3) was used as a baseline for comparison with other control and transport groups on release dates.

adult tag detector and fish separator traps at Bonneville, McNary, and Lower Granite Dams.

A total of 179 steelhead were recovered from August to November 1983 (Table 4). This is a relatively high number of recoveries considering that most steelhead from Dworshak NFH return after 2 years in the ocean. These preliminary returns would indicate a high survival of smolts released in 1982, and a subsequent large return of 2-ocean age adults is expected in 1984.

Lower river recoveries (Bonneville Dam adult separator and the Indian Zone 6 fishery) show approximately the same proportion of test (barged) as control fish returning (Table 4). The lack of transport benefit based on test to control (T/C) ratios was expected (Harmon, et al. 1983). In 1982, over 53,000 of the controls released were collected and transported from dams; and only 2,390 were estimated at John Day Dam. Thus it is conceivable that up to 96% $\left(\frac{53{,}000}{53{,}000 + 2{,}390} = 95.7\%\right)$ of the controls returning as adults had also been transported below Bonneville Dam. In contrast, at the uppermost sampling site (Lower Granite Dam adult separator) more control fish returned than barged fish in the fall of 1983. At this time, however, it is too early to determine the degree of homing impairment, as barged fish historically delay in the lower river and often do not pass Lower Granite Dam until spring.

These preliminary returns and total number of returns are not comparable between sampling sites because of differences in sampling rates (Table 4). However, the number of test to controls at each sampling location is comparable, and when returns are complete will provide the measure of degree of homing impairment.

Table 4.--Preliminary returns of adult steelhead from control and test releases of smolts imprinted to Dworshak NFH in 1982. Recoveries were made through November, 1983.

Test Number	Date, juveniles released	Number juveniles released	Number of adults recaptured				
			Bonneville Dam	Indian fishery	McNary Dam	Lower Granite Dam	Total
Control (Cl)	4-19-82	29,838	3	2	0	31	36
Test (Tl)	4-19-82	33,012	4	3	1	1	9
Test-pump (TlA)	4-19-82	32,185	3	0	0	2	5
Control (C2)	4-30-82	31,048	6	5	0	39	50
Test (T2)	4-30-82	32,911	6	11	1	13	31
Control (C3)	5-19-82	31,714	5	1	0	18	24
Test (T3)	5-19-82	29,456	8	4	2	5	19
Test (T4)	5-31-82	31,915	2	0	0	3	5
	TOTAL	252,079	37	26	4	112	179

Sampling of the sport and Indian fisheries (Clearwater River) has been coordinated with the State of Idaho and the Nez Perce Tribe and is now in progress (January 1984). Sampling at the homing site (Dworshak NFH) will commence in the spring of 1984.

SUMMARY

1. In 1982, a 5-year study was initiated to determine if steelhead, smolts from Dworshak NFH that were transported downriver by barge and released below Bonneville Dam would contribute a higher percentage of returning adults than smolts released at the hatchery to migrate downriver of their own volition.

2. The second year of research involved marking and releasing 251,491 steelhead smolts. A total of four barge transport test groups and four control groups of approximately 30,000 fish each were marked and released at about 14-day intervals from 20 April to 25 *May* 1983.

3. Approximately 29% of the control groups were transported to below Bonneville Dam by the routine CofE transportation operations at Lower Granite, Little Goose, and McNary Dams. Survival of true controls to John Day Dam ranged from 7.7 to 24.6% (average 14.8%). Estuary sampling showed highest recoveries for fish released late in the season.

4. The general health of each marked group of fish was monitored by analyses of body measurements; Na^+-K^+ ATPase levels in gill tissues; prevalence of Renibacterium salmninarum in kidney tissues; and the histopathological conditions existing in the gill, olfactory, and optic tissues. All groups ware considered to be in good health and well advanced in smoltification at release.

5. The relatively large number of l-ocean age adult recoveries (179) indicates a high survival of test and control fish released in 1982, and a large return of 2-ocean age adults is expected in 1984. Preliminary returns from the lower river indicate that test to control ratios were similar--as expected. The lack of benefit occurred because as many as 96% of the control fish returning may have also been transported below Bonneville Dam.

ACKNOWLEDGEMENTS

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APPENDIX A

A report on the Health Status of Dworshak National Fish Hatchery Steelhead Trout (Salmo gairdneri) used in the National Marine Fisheries Service Transportation Homing Study (Production Year 1982-1983).

A Report on the Health Status of Dworshak National Fish Hatchery Steelhead Trout (*Salmo gairdneri*) used in the National Marine Fisheries Service Transportation-Homing Study (Production Year 1982-1983),

by

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September 28, 1983

INTRODUCTION

The importance of, rearing a high-quality smolt has been realized in recent years. The release of large numbers of disease-infected or physiologically-inferior anadromous salmonids has resulted in poor adult returns. The additional stress of dam passage and/or transporation of downstream migrating smolts has emphasized the need for healthy fish.

This project was undertaken to assess the health status of the steelhead trout reared.at Dworshak National Fish Hatchery (DNFH) and used in the National Marine Fisheries Service (NMFS) transportation-homing study.

The report covers work performed under Contract No. 41 USC 252(c)(4) during the period March 1, 1982 through September 1, 1982.

METHODS AND MATERIALS

Eight groups of juvenile steelhead trout reared at DNFH during production year 1982-1983 were selected for the experiment. Each group consisted of 28,000-40,000 fish reared in separate 17' x 70' Burrows recirculating ponds in System II. The juvenile steelhead trout were maintained on single-pass raw water from 06/01/82-11/19/82, 90 percent reused water from 11/19/82-04/06/83, and returned to raw water prior to release on the selected dates. The fish were hand fed an OMP diet 8-10 times daily. All reused water was passed through large bibfiltration beds to reduce environmental ammonia (NH_3-N) and nitrite (NO_2-N) concentrations. Measurements of NH_3-N by direct nesslerization and NO_2-N by the sulfanilamide-NEDA method'were'mabe three times weekly. Average environmental ammonia and nitrite concentrations were 0.48+0.24 and 0.022+.0.14, respectively."' A mineral supplement of 20-30mg/l Na+, 5-lOmg/l. K+, and 30-40mg/l Cl-'was added to the water from 11/19/82-04/06/83. the eight groups of fish were nose tagged; freeze branded'and adipose clipped during December, 1982. Marking operations were supervised by Mr. Steve ~~Acord~~ Allard (NMFS, Clarkston, Washington).

Assessment of the physiological condition of the steelhead was based on the measurement of length, weight, condition factor, hematocrit, gill Na+/k+ ATPase activity and plasma Na+ and K+ concentrations. The disease status was determined by general macro- and microscopic examination, incidence of bacterial kidney disease (Renibacterum salmoninarum) and histological examination of gills, kidneys, livers and nasal epithelium. Blood parameters and gill Na+/K+ ATPase activities were assayed every two weeks for group 4 fish (pond 36) and several days prior to release in groups 1, 2, 3, 5, 6, 7, and 8. Blood samples were withdrawn from 16 fish at each sample point. Thirty fish were sampled for gill Na+/K+ ATPase activities at each point except the last sampling of group 4 which contained 60 fish. Gross examination and histological samples consisted of 60 fish from group 4 and 30 fish from groups 1, 2, 3, 5, 6, 7, and 8 prior to release.

The juvenile steelhead trout were randomly dipnetted from the ponds and anesthetized in a 75mg/l solution of tricaine methanesulfonate (MS-222, Argent Chemicals). Total length and weight were measured to the nearest millimeter and gram respectively. The condition factor was calculated using the formula K =weight(g)/length3(cm). Blood samples were withdrawn from the caudal artery using a heparinized 1.0cc tuberculin with a 25g x 5/8" needle (Pharmaseal). The syringe was gently hand rolled to ensure mixing of' heparin and blood and placed on ice. The syringe needle was removed 'to prevent hemolysis and the whole blood was gently injected into 350µl caraway tubes (VWR). The samples were centrifuged in a Beckmann TJ-6R centrifuge at 4°C for fifteen minutes at 2,000 x g. The tubes were cut above the plasma/ erythrocyte interface and the plasma placed in 0.5ml cups (VWR). Plasma'was stored at -25°C until assayed. The plasma Na+ and K+ concentrations were measured on a Radiometer FLM-3 Flame Photometer. Hematocrits were determined with a IEC microcapillary centrifuge and reader.

Immediately after blood sampling, approximately 0.1g of gill tissue was excised from the gill arches on the right side. The 'gill filaments were placed in 1.0ml of a cold (4°C) solution containing: 0.3 M socrose, 0.02M Na_2EDTA and 0.1 M imidazole. An additional group of fish were sampled to reach the required sample number. The filaments were quickly placed in a -25°C freezer and transferred to a -80°C freezer within 24 hours. Frozen gill samples were shipped on dry ice via Greyhound Bus Lines to the NMFS Field Station at Cook, Washington. Gill Na+/K+ ATPase activities were assayed by Dr. Wally Zaugg using the method of Zaugg (1982).

Thirty fish from groups 1, 2, 3, 5, 6, 7, and 8 and sixty fish from group 4 were sampled for histology prior to release Gill sections for histological examination were excised from the fish and placed in Bouin's fixative for 24 hours and transferred to 70 percent ETOH. A section of the'posterior kidney, the liver and the head (severed behind the eyes) were treated in a simlar manner. The samples were completely dehydrated, embedded in paraffin and sections were cut at 5µm and stained with hematoxylin and eosin-phloxine.

The prepared samples were examined by light microscopy. Histopahtological examinations were conducted by Mr. Charlie Smith and Mr. John Morrison of the U.S. Fish and Wildlife Service,Development Center at Bozeman, Montana.

During the sampling for histology, a small portion of the middle and posterior kidney was removed for determination of the incidence of Renibacterum salmoninarum. The sections were immediately placed and subsequently stored in 10 percent neutral buffered formalin. Slides were prepared by making a smear with a freshly-cuttissue section,air drying the slide and fixing it in absolute methanol for 10 minutes. The fixed slides were stored in a -25°C freezer. The incidence of Renibacterum salmoninarum was determined using the direct fluorescent antibody test (F.A.T.) as previously described (Bullock and Stuckey, 1975). Conjugate for direct F.A.T. was supplied by the Biologics Lab at the U.S. Fish and Wildlife Service National Fisheries Research Center at Leetown, West Virginia. Material from a kidney lesion in a known infected fish was used as a positive control, Approximately 100 fields per smear were examined with an American Optics fluorescent microscope. The rating of the incidence of Renibacterum salmoninarum was based on an arbitrary scale of O-4. Negative samples were given a value of 0, l-3 bacteria/field a +l, 4-10 bacteria/field a +2, 11-25 bacteria/field a +3, and greater than 25 bacteria/field a rating of +4.

Gross examination of the fish at each sample point was conducted by Mr. Joseph C. Lientt (Division 3 Fish Disease Biologist, U.S. Fish and Wildlife Service). The gills and mucous were examined for parasites and abnormalities by light microscopy. The general condition of the fins, coloration, descaling and mucous consistency were noted. The internal organs were examined for any, abnormalittes, and bacterial smears were made if warranted.

RESULTS

The pond number, brand, release date and population size of each group is' presented in Table 1. Group 7 had the largest number of fish (40,394) and group 5 the least number (28,979). The sample dates and numbers are listed. in Table 2. The mean length + standard deviation and mean weight + standard deviation are presented in Table 3. All groups attained a'mean size of >190mm by release; mean lengths ranged from 192-210mm. The minumum mean weight was 64+15.6g the maximum 80.7+21.5g. Table 4 lists the mean + standard deviation of weekly measurements (3x/week) of water temperature, pH, dissolved oxygen and NH_3-N concentrations.

The following sections report the data for the individual parameters and groups:

Plasma Na+ and K+ Concentrations and Hematocrits

The mean + standard deviation of plasma Nat and K+ concentrations and hematocrit values are depicted in Table 5. All individual and mean plasma Na+ concentrations are within the normal range for steelhead trout smolts at DNFH. A peak in plasma Na+ concentrations was observed in group 4 fish on 03/17/83. This shift has been shown to be indicative of smoltification changes in steelhead trout at DNFH by Bradley and Rourke (1983). All groups sampled after this date have lower plasma Na+ concentrations, similar to group 4 values after the peak.

A number of fish in groups 1 (6 fish), 2 (2), 3 (7), 5 (11), 6(7), 7 (1), and 8 (1) were found to have abnormally low plasma K+ concentrations. Group 4 also contained several individual's with low Kt levels on the following sample dates: 3/l (1 fish), 3/31 (3 fish), 4/19 (4 fish), and 5/19 (3 fish).

All individual hematocrit values were within the normal expected range. A total of eight individuals had values less than 30 percent.

Group No.	Pond No.	Brand	No. of Fish	Size (No./lb)	Total Length (mm)	Weight (lbs)	Release Date
1	28	RAF-1	30,544	5.95	198	5,133	04-20-83
2	40	RAF-2	34,741	5.55	204	6,260	05-03-83
3	36	RAF-3	33,364	6.17	198	5,408	05-03-83
4	34	RAF-4	31,240	5.74	207	5,442	05-25-83
5	30	RAZ-1	28,979	5.91	200	4,903	04-20-83
6	32	LAW-1	33,321	6.84	188	4,872	04-20-83
7	42	LAW-Z	40,394	5.36	197	7,536	05-03-83
8	38	LAW-3	34,656	6.19	204	5,599	05-24-83

Table 1. The brand, number, size, total length, weight and release date of the 8 groups of steelhead trout. The numbers and weights are based on NMFS sampling data from marking.

Group No.	Sample Date	No. of Fish
1	04-20-83	30
2	04-29-83	30
3	05-02-83	30
4	03-01-83	30
	03-17-83	30
	03-31-83	30
	04-14-83	30
	04-19-83	30
	05-05-83	30
	05-19-83	60
5	04-20-83	30
6	04-20-83	30
7	05-04-83	30
a	05-24-83	30

Table 2. The sample date and number of individuals sampled for the 8 groups.

Group No.	Sampling Date	Total Length (mm) x +_ SD	Total Length Range (mm)	Weight (g) x +_ SD	Weight Range (g)
1	04-20-83	192 + 26	136 - 237	68.8 + 26.4	22.4 - 123.9
2	04-29-83	205 + 21	154 - 235	77.7 + 21.3	36.6 - 128.0
3	05-02-83	205 + 17	181 - 246	74.7 + la	52.8 - 126.2
4	03-01-83	182 + 16	141 - 211	60.2 + 14.9	27.5 - 92.0
	03- 17-83	184 + 19	133 - 216	61.8 + 17.4	22.2 - 97.2
	03-31-83	193 + 20	140 - 232	68.7 + 20.2	26.9 - 113.4
	04-14-83	203 + 4	166 - 234	78.7 + 3.7	43.4 - 113.3
	04- 19-83	201 + 20	164 - 244	78.6 + 21.6	39.1 - 133.3
	05-05-83	204 + 13	179 - 228	77.6 + 16.8	53.6 - 121.0
	05-19-83	210 + 16.8	182 - 248	80.7 + 21.5	49.2 - 145.4
5	04-20-83	200 + 25.5	152 -. 247	75.4 + 25.3	32.5 - 135.6
6	04-20-83	192 + 17	141 - 234	66.9 + 17.3	27.2 - 126.1
7	05-04-83	197 + 16	164 - 231	64 + 15.6	38.4 - 101.0
8	05-24-83	203 + 16	171 - 248	70.1 + 18.2	34.0 - 122.7

Table 3. The means + standard deviations of length (mm) and weight (g). and the length and weight ranges at each sample date. Each value is the mean of 30 individuals except group 4 (05-19-83) which is 60 individuals.

Date	Temperature (°F)	Dissolved Oxygen (mg/ℓ)	pH	NH_3-N (mg/ℓ)
03/01	52.0 + 4.9	**10.2 + 0.90**	6.75 + 0.13	0.52 + 0.07
03/08	48.5 + 0.5	11.0 + 0.11	6.63 + 0.29	0.33 + 0.09
03/15	47.0 + 0.0	11.2 + 0.20	6.85 + 0.10	0.49 + 0.16
03/22	47.2 + 0.8	11.3 + 0.20	6.57 + 0.32	0.34 + 0.06
03/29	46.0 + 1.8	11.4 + 0.3	6.78 + 0.15	0.34 + 0.06
04/05	42.0 + 0.0	12.3 + 0.4	6.40 + 0.14	0.12 + 0.03
04/12	40.7 + 1.1	12.6 + 0.0	6.95 + 0.26	0.12 + 0.03
04/19	43.8 + 3.2	11.8 + 0.9	6.80 + 0.33	0.21 + 0.13
04/26	45.0 + 0.9	10.2 + 0.2	7.18 + 0.10	0.32 + 0.06
05/03	46.2 + 1.0	9.9 + 0.1	7.00 + 0.26	0.30 + 0.06
05/10	47.2 + 1.0	10.8 + 0.8	6.90 + 0.40	0.16 + 0.03
05/17	48.3 + 0.6	11.7 + 0.1	7.20 + 0.15	0.13 + 0.03
05/24	50.0 + 0.5	11.1 + 0.3	7.02 + 0.41	0.13 + 0.09

Table 4. Water temperature, dissolved oxygen concentration, pH and NH_3-N concentration of System II for each week of the study. Each value is the mean + standard deviation of three readings/week.

Group No.	Date	Na+ (mEq/ℓ)	K+ (mEq/ℓ)	Hct (%)
1	04-20-83	159 + 2	0.9 + 0.3	38 ± 3
2	04-29-83	152 + 1	1.2 + 0.1	38 + 1
3	05-02-83	153 + 3	0.7 + 0.3	37 + 3
4	03-01-83	158 + 4	1.4 + 0.4	39 + 3
	03-17-83	167 + 2	2.0 + 0.1	32 + 4
	03-31-83	164 + 1	1.3 ± 0.2	34+0.8
	04-14-83	157 + 1	1.9 + 0.6	35 + 1
	04-19-83	157 + 5	1.2 + 0.4	38 + 4
	05-05-83	158 + 4	1.8 + 0.3	35+3
	05-19-83	161 + 3	1.6 + 0.8	38+3
5	04-20-83	156 + 4	0.7 + 0.4	39±5
6	04-20-83	155 + 4	0.9 + 0.5	38+3
7	05-04-83	156 + 2	1.4 +0.4	36 +2
a	05-24-83	158 + 3	1.6 +0.4	36 + 3

Table 5. **Plasma Na+ and K+ concentrations and hematocrit values of the test groups. Each value is the mean + standard deviation of 15 individuals.**

The plasma Na+ and K+ concentrations and hematocrit values for each individual fish are listed in Appendix A.

Gill Na+/K+ ATPase Activity and Condition Factor

A statistically significant increase in gill Na+/K+ ATPase activity and decrease in condition factor occurred in group 4 during the monitoring period. Table 6 presents the mean + standard deviations of gill Na+/K+ ATPase activity and condition factor. Activities in group 4 increased significantly from 5.6+1.2 umoles ATP hydrolyzed/mg protein/hr on 3/l to 13.2+4.7 on 5/5. The mean ATPase activities of group 4 at release were slightly lower (11.5+3.2) than activities from fish sampled on 5/5 (13.2+4.7). The ATPase activities of four individuals (19.9, 20.5, 23.0, 35.0) from group 1 (4/20) are much higher than activities in the other individuals in the group. In group 2 (4/29), five abnormally-low ATPase activities were recorded. Two ATPase values are missing in group 5 because of loss of the sample during the assay. All other individuals appear to have gill Na+/K+ ATPase activities within the normal range.

The mean condition factor of group 4 fish decreased significantly from 0.98+0.05 on March 1 to 0.85+0.06. This decrease in condition factor was consistent in other groups; the later the release date, the lower the mean condition factor. Individual gill, Na+/K+ ATPase activities and condition factors can be found in Appendix A.

Incidence of Renibacterium salmoninarum

The incidence of Renibacterium salmoninarum for each group is presented in Table 7. The highest rating for any individual using the previously described 0-4 system was a +l. All eight groups had at least 2 positive (+l) samples; the highest incidence was 5 positive (+l) samples in a 30 fish sample (group 5). The percentage of infected fish ranged from 6.7 percent for group 8 to 16.7 percent for group 5. No gross kidney lesions or abnormalities were

Group No.	Date	ATPase umoles ATP hydrolyzed/mg protein/hr	Condition Factor
1	04-20-83	11.5 + 6.2	0.93 + 0.05
2	04-29-83	9.3 ± 2.0	0.89 + 0.07
3	05-02-83	13.1 + 3.6	0.85 + 0.04
4	03-01-83	5.6 + 1.2	0.98 + 0.05
	03-17-83	5.5 + 1.0	0.96 + 0.07
	03-31-83	6.9 + 1.7	0.93 + 0.04
	04-14-83	8.1 + 1.1	0.93 + 0.05
	04-19-83	8.9 + 1.7	0.95 + 0.04
	05-05-83	13.2 + 4.7	0.90 + 0.05
	05-19-83	11.5 + 3.2	0.85 + 0.06
5	04-20-83	8.5+1.2	0.91 + 0.07
6	04-20-83	7.8 + 2.0	0.92 + 0.05
7	05-04-83	13.4 + 3.2	0.82 + 0.04
8	05-24-83	10.8 + 3.2	0.82 + 0.05

Table 6. Mean + standard deviation of gill Na+/K+ ATPase activities and condition factor values. The group 4 (05-19-83),sample contained 60 individuals, all others are 30 fish samples.

Group No.	No. of +1 samples	Percentage of +l samples
1	3/30	10.0
2	4/30	13.3
3	3/30	10.0
4	8/60	13.3
5	5/30	16.7
6	4/30	13.3
7	4/30	13.3
a	2/30	6.7

Table 7. The number and percentage of fish in each group infected with *R.* salmoninarum.

observed in any fish. The status of each individual is presented in Appendix B.

Histological Examination

The histological examination of gills, nasal epithelium, livers, and kidney tissues revealed several abnormalities. Gills collected from the majority of smolts in late April-early May (groups 1, 2, 5, 6, and 7) exhibited considerable hypertrophy of lamellar epithelium. Scattered fusion of some gill lamallae was observed but was considered to be mild. Gills from smolts in groups 3, 4, and 8 appeared to be in extremely good condition.

A similar occurrence was observed in the nasal epithelium. Considerable edema and mild diffuse necrosis of nasal'sensory epithelial cells were found in a large percentage of fish in groups 1, 2, 5, 6, and 7.' The nasal epithelium examined from smolts in groups 3, 4, and 8 appeared in good condition with only occasional focal areas of edema.

Liver tissue and kidneys from all groups were essentially normal. Some mild swelling of kidney tubule epithelium was observed but only occasionally.

The complete histological report and micrographs submitted by Mr. C. Smith are contained in Appendix D.

Gross Examination

A minimum of 30 fish from each group were examined at each sampling date. Pre-marking exams showed that the fish were in good health. Light parasite loads of Gyrodactylus, Epistylis and Ichthyopthirius and light-to-moderate dorsal erosion were noted.

Examinations in March revealed similar parasite loads and increased dorsal fin erosion. Light gill swelling and extension of some filaments beyond the

opercles became apparent at this time. Some short rod bacteria and debris were found in the gills. Fish health remained good. In late March, gill swelling and moderate-heavy dorsal fin erosion persisted.

During April, fin erosion and gill swelling were reduced. By mid-April fish were reported to be in very good condition. All groups of fish had attained smolt morphological characteristics by this time. All fish maintained at the hatchery during the remainder of the rearing period were found to be of high quality.

Fish release prior to 05/03/83 (groups 1, 2, 3, 5, 6, and 7) exhibited more gill swelling and dorsal erosion than those released later in May (groups 4 and 8). However, fish health in the early release groups did not appear to be impaired. No viral or bacterial infections occurred during the sampling period.

Appendix C contains a summary of the pre-release fish exams by Joseph C. Lientz (Division 3 Fish Disease Biologist).

DISCUSSION

The data indicate that the fish were in various degrees of health. The mean plasma Na+ concentration of eachgroup is within the normal expected range. The increase in plasma Na+ concentrations observed on 03/17/83 in group 4 is indicative of smoltification in steelhead trout at DNFH (Bradley and Rourke, 1983). It is not possible to say that all the groups went throughthis change due to the single 'sample point. However, the plasma Na+ concentrations of the other groups at release are similar to those in group 4.

The low plasma K+ concentrations in several smolts indicate a slight problem with ionic balance. It is normal to have a small number of individuals with low plasma K+ in a population but 'groups 1 3, 5, and 6 have an excessive number 1.

Gill Na+/K+ ATPase activities increased and condition factor: values decreased as would be expected in fish undergoing smoltification. The cause of the four low Na+/K+ ATPase activities in group 2 smolts is unknown but could be the result of problems with the assay. The four high activities from group 1 (04/20) may also be due to assay difficulties or simply fish with abnormally high activities.

The incidence of Renibacterium salmoninarum in steelhead trout smolts was higher than in previous years. The increased number of spring chinook salmon being reared at DNFH might be the cause. This increased incidence does not appear to have had any detrimental effects on the steelhead trout smolts. No lesions or abnormalities were visible by gross examination and no subclinical signs were seen during histological examination. Fish health problems from R. salmoninarum may occur in steelhead trout at DNFH in the future but as of this time no effects have been seen.

Histological examinations revealed that smolts released in late April early May (groups 1, 2, 5, 6, and 7) exhibited several abnormalities,

particularly epithelial hypertrophy and edema in gill and nasal-tissues. Fish released later in May (groups 3, 4, and 8) had much fewer anomalies. A possible cause for this phenomenon might be related to the high level of environmental solids in late March - early April. Prior to the switch from reused water to single-pass water on 04/07/83, the environmental solids reached maximum levels for the year. The elevated solids concentration may have caused the observed gill and nasal epithelium damage,., The decreased solids during raw water rearing might allow recovery of tissues damaged by solids. The longer recovery time before sampling of group 3, 4, and 8 could explain the better conditions of gill and nasal epithelium in fish of these groups.

In summary it can be concluded that the fish in all groups were in good health and well advanced in smoltification. The major difference between: groups is the higher incidence of gill and nasal epithelial hyperplasia in groups 1, 2, 5, 6, and 7. It might be worthwhile to consider 'this when examining adult returns.

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APPENDIX A

Individual values and mean + standard deviation for the weight, length, K factor, hematocrit (Hct), plasma Na^+ and K^+ concentrations, and gill Na^+/K^+ ATPase activity of all fish sampled.

Group 1 Pond 28 4/20/83

	Weight (g)	Ttoal ength(mr	K factor	Hct (%)	Plasma Na· (mEg/l)	Plasma K+ (mEg/l)	Gill ATPase Activity oles ATP hydrolyzed/mg protein/hr)	
1	53.4	179	0.93	38	157	0.6	6.6	
2	82.4	209	0.90	38	160	0.6	7.4	
3	50.3	172	0.99	38	159	0.7	7.6	
4	49.8	175	0.93	43	159	0.5	9.1	
5	49.2	211	1.00	37	162	0.6	10.7	
6	72.6	202	0.88	35	159	1.3	9.1	
7	105.0	221	0.97	40	162	0.9	9.6	
8	40.6	164	0.92	36	161	0.8	8.1	
9	67.1	202	0.81	40	156	0.6	6.7	
10	61.8	190	0.90	31	161	0.9	7.3	
11	35.4	155	0.95	41	155	1.0	12.0	
12	102.5	228	0.86	36	156	1.1	8.3	
13	22.4	136	0.89	38	159	1.0	6.2	
14	34.2	153	0.95	40	156	1.0	9.1	
15	58.8	187	0.90	33	161	1.6	9.7	
16	118.8	237	0.89				7.4	
17	60.2	188	0.91				0.7	
13	58.8	185	0.93				9.1	
19	79.9	200	1.00				8.5	
20	41.5	160	1.01				13.9	
21	123.9	230	1.02				15.9	
22	87.6	212	0.92				7.8	
23	33.7	150	1.00				9.8	
24	102.7	225	0.90				20.5	
25	92.1	220	0.86				19.9 *	
26	66.9	198	0.86				23.0 *	
27	76.2	201	0.94				35.0*	
28	56.9	180	0.98				10.7	
29	83.7	207	0.94				15.5	
30	50.4	176	0.92				12.3	
	68.8+26.4	192+26	0.93+0.05	38+3	159+2	0.9+0.3		11.5+6.2w* 9.4+2.6w/o*

Group 2 Pond 40 4/29/83

	Weight (g)	Total Length(m	K factor	Hct (%)	Plasma Na· (mEq/l)	Plasma K+ (mEq/l)		Gill ATPase Activity (umoles ATP hydrolyzed/mg prot
1	87.1	216	0.86	38	156		1.1	10.0
2	73.2	200	0.92	41	154		1.3	5.4
3	79.3	215	0.80	38	152		1.5	10.2
4	50.2	176	0.92	41	155		1.2	11.1
5	128.0	233	1.01	32	153		1.7	7.4
6	97.8	225	0.86	38	155		1.8	2.7 *
7	101.0	227	0.86	40	157		1.6	3.8
8	84.4	219	0.80	36	153		1.7	0.1
9	56.6	182	0.94	33	150		0.9	0.4 *
10	95.8	225	84	40	153		0.6	7.2
11	99.3	229	0.83	36	150		0.9	3.8*
12	68.4	201	0.84	37	145		0.7	9.7
13	76.0	209	0.83	38	151		1.2	9.0
14	86.7	218	0.84	41	152		0.9	14.2
15	46.5	174	0.88		152		1.0	12.7
16	85.5	218	0.83	37	151		1.2	9.6
17	74.2	208	0.82					9.7
13	67.8	199	0.86					8.0
19	88.5	219	0.84					8.3
20	72.8	202	0.88					11.2
21	50.0	177	0.90					10.9
22	39.8	154	1.09					8.8
23	81.2	209	0.89					8.3
24	67.9	200	0.85					9.3
25	70.5	193	0.98					10.2
26	79.3	207	0.89					10.5
27	59.2	196	0.92					9.1
28	36.6	160	0.89					5.8
29	102.2	216	1.01					7.1
30	114.2	235	0.88					8.4
	77.7+21.3	205+21	0.89+0.07	38+1	152+1		1.2+0.1	9.3+2.0 w/o* 8.1+3.3 w*

Group 3 Pond 36 5/2/83

	Weight (g)	Total ength(mm	K factor	Hct M	Plasma Na+ (mEq/l)	Plasma K+ (mEq/l)	Gill ATPase Activity oles ATP hydrolyzed/mg Protein
1	62.3	193	0.87	37	155	0.9	9.8
2	98.6	229	0.82	37	154	0.4	7.2
3	66.2	193	0.92	33	153	0.9	15.9
4	70.7	208	0.79	36	153	0.5	17.4
5	104.8	230	0.86	37	145	0.4	18.0
6	53.5	187	0.82	39	155	0.8	9.6
7	54.2	186	0.84	39	157	0.6	7.3
8	71.2	205	0.83	38	156	0.9	17.1
9	52.6	181	0.89	35	152	0.8	14.3
10	61.6	190	0.90	39	156	0.3	10.9
11	83.7	219	0.80	38	152	0.5	16.6
12	86.5	219	0.82	41	157	0.8	12.8
13	62.3	192	0.88	45	152	0.6	12.5
14	70.7	207	0.80		152	1.1	9.7
15	78.1	205	0.93	31	146	1.4	12.4
16	126.2	246	0.85				9.5
17	53.3	186	0.83				20.5
18	87.8	216	0.87				17.1
19	71.9	201	0.89				13.2
20	89.7	219	0.85				18.6
21	69.2	199	0.88				16.0
22	91.5	218	0.88				8.6
23	92.6	222	0.85				10.7
24	53.1	184	0.85				10.9
25	73.9	206	0.85				13.8
26	96.5	229	0.80				16.1
27	63.6	192	0.90				12.3
28	62.5	193	0.87				10.3
29	52.8	184	0.85				10.0
30	81.1	212	0.85				12.7
	74.7+18	205+17	0.85+0.04	37+3	153+3	0.7+0.3	13.1+3.6

Group 4-1 Pond 34 03-01-83

	Weight (g)	Total engtln(mm	K factor	Hct (%)	Plasma Na+ (mEq/l)	Plasma K+ (mEq/l)	Gill ATPase Activity moles ATP hydrolyzed/mg Protein/
1	50.1	176	0.92	38	160	1.4	7.4
2	92.0	210	0.99	38	161	1.5	5.5
3	68.8	192	0.97	32	161	1.2	4.7
4	56.5	180	0.97	39	156	1.2	4.2
5	50.3	173	0.97		165	1.5	5.0
6	51.2	175	0.96	39	155	1.3	5.5
7	57.6	184	0.92	39	154	1.5	5.2
8	59.9	181	1.01	39	157	1.8	4.8
9	75.6	200	0.95	39	159	1.4	5.1
10	67.2	189	1.00	45	162	0.8	5.1
11	82.8	204	0.97	40	161	1.3	5.3
12	64.0	184	1.03	44	152	0.7	5.8
13	32.4	150	0.96	33	156	1.8	6.8
14	27.5	141	0.98	35	154	2.5	8.0
15	63.0	188	0.95	39	164	1.5	6.7
16	51.9	167	1.11	40	157	1.3	5.9
17	58.9	185	0.93				5.7
18	29.7	143	1.02				7.0
19	91.9	211	0.98				5.4
20	63.7	190	0.93				7.0
21	59.3	184	0.95				8.7
22	72.8	197	0.95				4.8
23	57.7	178	1.02				4.8
24	49.9	171	1.00				5.6
25	56.8	176	1.04				4.9
26	66.9	189	0.99				3.6
27	55.4	179	0.97				4.5
28	64.2	183	1.05				4.1
29	63.3	184	1.02				4.8
30	63.9	194	0.88				4.8
	60.2tl4.9	182tIG	98	390	+158.00	+1.40	+5.60

Group 4-2 Pond 34 03-17-83

	Weight (g)	Total ength(mm	K factor	Hct (%)	Plasma Na+ (mEq/l)	Plasma K+ (mEq/l)	Gill ATPose Activity moles ATP hydrolYzed/mg Protein
1	61.2	184	0.98	34	168	2.5	4.4
2	47.0	167	1.01	26	168	2.2	5.8
3	66.4	208	0.74	30	180	2.6	6.0
4	51.7	175	0.96	28	181	2.3	6.2
5	58.2	182	0.97	28	157	2.4	8.8
6	59.0	185	0.93	32	165	2.3	6.3
7	87.8	208	0.98	32	177	2.3	7.7
8	22.2	133	0.94	33	169	2.5	5.2
9	71.5	201	0.88	29	159	1.2	5.7
10	89.4	212	0.94	41	166	1.1	4.5
11	61.2	192	0.86	33	159	1.3	4.4
12	75.6	201	0.93	38	153	1.0	5.0
13	90.2	208	1.00	36	171	1.8	5.7
14	30.9	149	0.93	32	165	2.2	5.4
15	59.4	184	0.95	32	167	2.0	5.9
16	42.9	164	0.97	32	160	2.0	4.9
17	33.1	152	0.94				4.5
13	62.1	188	0.93				4.9
19	97.2	216	0.96				4.0
20	50.9	172	1.00				5.2
21	55.2	175	1.03				5.5
22	56.5	175	1.05				5.2
23	72.0	194	0.99				4.8
24	5.4	174	1.03				5.5
25	70.9	196	0.94				5.4
26	73.4	189	1.09				5.7
27	68.4	194	0.94				4.7
28	61.9	182	1.03				5.8
29	73.3	195	0.99				6.3
30	49.7	178	0.88				5.5
	61.8+17.4	184+19	0.96+0.07	32+4	167+2	2.0+0.1	5.5+1.0

Group 4 - 3 Pond 34 03-31-83

	Weight (g)	Total ength(mm	K factor	Hct (%)	Plasma Na+ (mEg/l)	Plasma K+ (mEg/l)	Gill ATPose Activity moles ATP hydrolyzed/mg protein/
1	67.2	192	0.95	33	171	1.9	10.5
2	118.2	232	0.95	37	168	1.4	10.1
3	54.3	179	0.95	35	163	1.8	6.7
4	80.1	205	0.93	32	162	1.3	8.5
5	113.4	233	0.90	38	171	2.3	7.0
6	82.5	211	0.88	30	165	2.2	10.7
7	57.4	184	0.92	35	165	1.7	5.0
8	55.3	186	0.86	30	164	1.9	6.3
9	84.8	209	0.93	40	161	0.5	6.1
10	60.4	184	0.97	35	161	0.5	5.1
11	78.8	201	0.97	33	166	0.9	6.4
12	75.2	200	0.94	37	162	0.6	6.8
13	65.7	189	0.97	37	162	1.1	5.4
14	60.4	187	0.92	41	165	0.9	5.6
15	63.7	193	0.89	36	166	1.1	6.8
16	44.5	173	0.86	35	159	1.0	6.8
17	50.7	174	0.96				6.5
13	26.9	140	0.98				5.2
19	68.5	193	0.95				4.4
20	41.6	164	0.94				5.8
21	82.2	209	0.90				8.2
22	91.9	221	0.85				5.9
23	88.2	210	0.95				4.7
24	73.7	196	0.98				8.1
25	59.8	189	0.89				6.5
26	54.0	174	1.03				6.7
27	65.8	194	0.90				8.0
28	57.1	184	0.92				9.5
29	92.4	217	0.90				6.7
30	47.1	166	1.03				6.6
	68.7+20.0	193+20	0.93+0.04	34+0.8	164+1	1.3+0.2	6.9+1.7

Group 4-4 Pond 34 04-14-83

	Weight (g)	Total Length(mm)	K factor	Hct M	Plasma Na+ (mEg/l)	Plasma K+ (mEg/l)	Gill ATPose Activity moles ATP hydrolyzed/mg Protein
1	71.1	196	0.94	33	157	1.5	8.9
2	71.5	193	0.96	28	157	1.6	8.0
3	65.3	195	0.88	34	156	1.5	8.8
4	56.3	181	195	40	161	1.7	8.4
5	102.3	223	0.92	34	162	3.5	10.1
6	93.9	223	0.85	29	158	2.7	8.3
7	112.5	234	0.88	32	160	2.3	8.9
8	54.8	180	0.94	32	154	2.0	7.9
9	103.7	223	0.94	29	159	2.4	9.9
10	113.3	233	0.90	36	158	1.2	10.1
11	104.8	231	0.85	38	157	1.4	9.6
12	61.9	195	0.83	36	155	1.6	6.9
13	62.7	193	0.87	37	153	1.6	6.5
14	88.0	212	0.92	37	159	2.0	4.5
15	104.6	229	0.87	38	158	1.4	6.4
16	80.9	202	0.98	41	159	1.4	7.4
17	58.5	185	0.92				8.2
13	73.6	196	0.98				6.2
19	73.4	199	0.93				7.8
20	105.9	226	0.92				7.6
21	97.3	220	0.91				6.0
22	57.1	177	1.03				7.5
23	71.1	193	0.99				10.1
24	46.9	166	1.03				9.5
25	74.5	204	0.88				6.8
26	70.9	190	1.03				8.4
27	87.3	210	0.94				8.3
28	43.4	170	0.88				7.8
29	92.2	215	0.93				6.8
30	61.8	186	0.96				5.7
	78.7+.37	203+4	0.93+0.05	35+1	157+1	1.9+0.6	8.1+1.1

Group 4-5 Pond 34 04-19-83

	Weight (g)	Total engthmm	K factor	Hct (%)	Plasma Na+ (mEq/l)	Plasma K+ (mEq/l)	Gill ATPase Activity moles ATP hydrolyzed/mg protein/
1	99.4	219	0.95	38	157	0.6	12.6
2	79.9	206	0.91	37	164	0.7	9.5
3	71.8	195	0.97	34	156	1.1	7.6
4	84.4	205	0.98	27	162	1.9	12.0
5	133.3	244	0.92	34	156	1.7	10.0
6	53.0	174	1.01	37	156	1.4	7.2
7	99.0	221	0.92	33	151	1.7	10.5
8	48.4	170	0.99	41	160	1.3	10.2
9	90.2	208	1.00	44	155	1.1	9.3
10	53.2	177	0.96	36	156	1.4	7.6
11	104.8	224	0.93	40	159	1.0	11.1
12	86.5	210	0.93	43	152	0.6	11.6
13	73.5	201	0.91	36	153	1.6	7.2
14	99.3	223	0.90	42	159	0.7	9.3
15	65.2	191	0.94	40	153	1.1	6.5
16	59.0	185	0.93	41	169	1.3	7.5
17	69.3	198	0.89				7.6
13	98.1	216	0.97				8.9
19	87.8	211	0.93				12.0
20	60.1	184	0.96				9.6
21	69.0	188	1.04				6.9
22	91.8	220	0.86				10.4
23	70.4	199	0.89				7.5
24	46.5	168	0.98				7.4
25	103.5	218	1.00				7.3
26	57.0	178	1.01				8.9
27	87.7	208	0.97				8.2
28	101.3	222	0.93				8.0
29	74.3	199	0.94				8.9
30	39.1	164	0.89				7.0
	78.6+21.6	201+20	0.95+0.04	38+4	157+5	1.2+0.4	8.9+1.7

Group 4-6 Pond 34 05-19-83

	Weight (g)	Total engthmm	K factor	Hct (%)	Plasma Na+ (mEg/l)	Plasma K+ (mEg/l)	Gill ATPase Actlvlty mole ATP hydrolyzed/mg protein/
1	72.3	204	0.85	36	160	1.8	16.0
2	72.1	206	0.82	34	160	1.6	10.1
3	68.9	201	0.85	32	151	1.3	10.0
4	53.6	182	0.89	39	157	1.4	21.5
5	78.4	204	0.92	38	163	1.9	12.5
6	93.1	216	0.92	38	161	1.6	14.2
7	73.9	210	0.80	39	159	1.6	18.3
8	74.8	205	0.87	33	156	2.3	9.5
9	106.3	225	0.93	35	160	1.7	13.5
10	57.1	187	0.87	31	160	2.2	9.1
11	55.5	180	0.95	33	163	1.6	9.5
12	76.2	210	0.92	37	156	1.7	18.4
13	75.0	206	0.86	34	153	2.0	8.2
14	69.2	199	0.88	34	160	1.9	9.9
15	72.2	197	0.94	44	160	1.3	9.7
16	54.2	179	0.94	32	149	2.3	7.9
17	54.4	187	0.83				14.6
18	79.7	206	0.91				9.3
19	82.1	209	0.90				20.4
20	79.9	208	0.89				18.6
21	76.1	203	0.91				20.3
22	91.7	211	0.98				9.0
23	81.9	203	0.98				12.0
24	118.0	228	1.00				17.4
25	121.0	234	0.94				14.1
26	77.7	203	0.93				23.8
27	84.4	215	0.85				9.6
28	84.4	214	0.86				8.8
29	84.2	210	0.91				8.1
30	59.1	186	0.92				18.7
	77.6+16.8	204+13	0.90+0.05	35+3	158+4	1.80+0.3	13.2+4.7

Group 4-7 Pond 34 05-19-83

	Weight (g)	Total Length(m)	K factor	Hct (%)	Plasma Na+ (mEg/l)	Plasma K+ (mEg/l)	Gill ATPase Activity moles AIP hydrolyzed/mg protein/hr)
1	101.5	232	0.81	35	164	2.1	8.8
2	123.2	242	0.87	37	161	2.1	10.5
3	58.2	192	0.83	36	162	1.6	17.2
4	60.2	189	0.89	36	161	2.0	9.4
5	90.6	223	0.82	37	163	2.4	17.1
6	77.4	212	0.81	37	163	3.0	15.8
7	71.3	204	0.84	37	162	2.1	14.0
8	110.8	233	0.88	40	157	2.4	11.8
9	65.1	206	0.74	35	156	0.9	14.1
10	79.6	211	0.85	42	157	0.5	12.1
11	65.8	198	0.85		160	0.5	15.1
12	109.9	242	0.78	42	161	0.7	9.6
13	76.1	208	0.85	39	166	1.0	9.5
14	96.0	?28	0.84	40	163	1.7	10.0
15	65.0	199	0.82	41	163	0.9	9.4
16	96.4	225	0.85	43	157	1.6	16.1
17	99.2	221	0.96				11.8
18	57.2	189	0.85				19.0
19	50.1	183	0.82				17.0
20	100.9	228	0.85				14.9
21	75.7	199	0.96				9.5
22	68.2	200	0.85				7.3
23	55.1	190	0.80				9.6
24	69.5	199	0.88				13.4
25	145.4	242	1.03				6.0
26	88.4	221	0.82				11.5
27	78.0	208	0.87				9.7
28	82.1	214	0.84				20.6
29	85.5	213	0.88				9.1
30	93.5	214	0.95				7.9
31	94.1	224	0.84				9.8
32	103.7	228	0.87				10.4
33	49.2	182	0.82				10.9
34	67.5	201	0.83				18.1
35	67.9	202	0.82				7.2
36	72.0	203	0.86				8.9
37	62.4	190	0.91				7.9
38	66.9	203	0.80				9.6
39	134.9	248	0.88				7.9
40	59.6	199	0.76				13.0
41	100.1	226	0.87				10.7
42	71.8	197	0.94				11.4
43	66.5	201	0.82				17.3
44	58.3	194	0.80				9.9
45	86.2	218	0.83				9.7
46	59.6	200	0.75				13.4
47	75.2	194	1.03				11.2
48	94.1	221	0.87				9.0
49	66.4	205	0.77				14.5
50	70.2	210	0.76				10.0
51	97.8	223	0.88				11.3
52	55.2	186	0.86				11.3
53	73.1	210	0.79				7.7
54	134.8	248	0.88				11.7
55	54.3	185	0.86				11.6
56	77.0	213	0.80				11.3
57	85.6	219	0.81				11.1
58	97.5	230	0.80				10.4
59	77.7	215	0.80				9.9
60	64.3	196	0.85				7.7
	80.7+21.5	210+16.8	1.85+0.06	38+3	161+3	1.6+0.8	11.5+3.2

Group 5 Pond 30 04-20-83

	Weight (g)	Total Length(mm	K factor	Hct (%)	Plasma Na+ (mEq/l)	Plasma K+ (mEq/l)	Gill ATPase Activity moles ATP hydrolyzed/mg protein
1	124.7	239	0.91	42	0.00	0.3	8.9
2	104.8	234	0.82	43	161	0.4	7.3
3	65.2	193	0.91	46	156	0.3	9.0
4	79.9	212	0.84	35	156	0.5	9.2
5	86.5	214	0.88	42	157	0.3	7.7
6	38.5	158	0.98	36	158	1.1	8.0
7	135.6	247	0.90	29	148	1.7	11.4
8	63.8	195	0.86	37	160	0.7	8.9
9	59.8	184	0.96	35	159	0.6	
10	35.0	152	1.00	39	153	0.6	
11	95.8	220	0.90	37	156	0.6	7.9
12	77.8	211	0.83	41	158	0.7	9.5
13	65.3	197	0.85	47	153	0.4	8.6
14	71.4	194	0.98	37	153	1.0	7.6
15	90.4	212	0.95	38	161	1.0	9.1
16	89.4	213	0.93				8.0
17	68.2	204	0.80				9.0
18	65.3	197	0.85				8.3
19	87.8	220	0.82				0.6
20	59.9	178	1.06				9.8
21	32.5	148	1.00				8.0
22	92.1	218	0.89				7.4
23	71.1	204	0.84				6.3
24	113.4	228	0.96				8.7
25	98.5	222	0.90				10.5
26	36.9	156	0.97				6.7
27	60.9	182	1.01				7.6
28	77.7	209	0.85				9.1
29	62.1	188	6.93				9.0
30	51.0	174	0.97				9.9
	75.4+25.3	200+25.5	0.91+0.07	39+5	156+4	0.7+0.4	8.5+1.2

Group 6 Pond 32 4/20/83

	Weight (g)	Total Length(mm	K factor	Hct (%)	Plasma Na+ (mEq/l)	Plasma K+ (mEq/l)	Gill ATPose Activity ATP hydrolyzed/mg proteln/hr)
1	85.6	212	190	38	156	0.4	6.6
2	126.1	234	0.98	38	158	0.6	6.0
3	59.2	181	1.00	38	156	0.8	7.1
4	63.8	196	0.85	43	148	0.3	5.4
5	61.7	186	0.96	37	154	0.6	5.1
6	61.8	188	0.93	35	156	0.9	4.9
7	59.7	184	0.96	40	154	0.9	6.9
8	50.5	179	0.88	36	150	0.7	8.7
9	74.2	200	0.93	40	152	0.7	7.6
10	62.0	191	0.89	31	161	1.3	10.6
11	52.9	177	0.95	41	160	1.1	7.0
12	69.8	196	0.93	36	161	1.7	5.3
13	55.8	183	0.91	38			14.5
14	71.9	202	0.87	40	156	0.8	9.7
15	58.0	182	0.96	33	155	2.1	7.5
16	70.4	207	0.79				7.2
17	82.9	204	0.98				7.9
13	83.9	204	0.99				9.6
19	75.4	202	0.91				6.6
20	68.2	192	0.96				8.5
21	69.2	196	0.92				9.0
22	59.6	184	0.96				6.5
23	48.8	176	0.90				10.1
24	72.7	207	0.82				9.3
25	61.1	187	0.93				8.7
26	56.7	184	0.91				7.0
27	66.7	188	1.00				7.9
28	97.6	222	0.89				10.2
29	52.6	183	0.86				7.1
30	27.2	141	0.97				6.9
	66.9+17.3	192+17	0.92+0.05	38.3	155+4	0.9+0.5	7.8+2.0

Group 7 Pond 42 42 05-04-83

	Weight (g)	Total ength(mm	K factor	Hct (%)	Plasma Na+ (mEg/l)	Plasma K+ (mEg/l)	Gill ATPose Activity noles ATP hydrolyzed/mg protein/
1	90.9	227	0.78	36	159	1.1	11.6
2	62.5	196	0.83	34	154	1.1	8.3
3	52.1	188	0.78	39	159	1.0	19.7
4	49.6	184	0.80	36	157	0.8	11.4
5	60.3	196	0.80	37	159	1.1	20.7
6	60.7	197	0.79	34	155	1.0	12.3
7	47.3	178	0.84	35	159	1.4	14.0
8	57.8	191	0.83	34	156	1.2	10.4
9	78.6	209	0.86	39	159	2.2	13.0
10	76.2	214	0.78	35	152	1.3	12.3
11	58.2	196	0.77	37	154	1.5	12.4
12	87.5	211	0.93	38	153	1.8	9.2
13	63.5	194	0.87	36	155	1.8	17.5
14	81.8	217	0.80	34	153	2.0	10.6
15	67.6	203	0.81	38	155	1.6	10.6
16	61.0	195	0.82				20.1
17	101.0	231	0.82				13.6
13	38.4	164	0.87				13.5
19	78.8	210	0.85				11.5
20	95.2	230	0.78				13.2
21	52.4	185	0.83				11.8
22	53.3	188	0.80				16.2
23	58.7	189	0.87				11.1
24	65.8	197	0.86				11.5
25	42.4	173	82				10.1
26	58.0	193	0.81				13.3
27	61.7	198	0.79				17.9
28	49.3	179	0.86				13.7
29	55.0	193	0.77				14.9
30	57.7	195	0.78				16.5
	64+15.6	197+16	0.82+0.04	36+2	156+2.5	1.4+0.4	13.4+3.2

Group 8 Pond 38 05-24-83

	Weight (g)	Total Length(mm	K factor	Hct (%)	Plasma Na+ (mEq/l)	Plasma K+ (mEq/l)	Gill ATPose Activity moles ATP hydrolyzed/mg protein/
1	57.3	192	181	33	157	1.4	9.9
2	119.6	240	0.87	36	163	1.5	10.1
3	34.0	171	0.68	32	160	2.0	8.1
4	75.1	209	0.82	38	162	0.9	8.4
5	67.7	203	0.81	40	160	1.6	14.6
6	62.9	207	0.71	35	156	2.1	12.3
7	66.9	204	0.79	35	161	1.3	8.8
8	75.4	203	0.90	38	160	1.7	6.8
9	64.0	198	0.82	37	159	1.9	9.0
10	68.9	197	0.90	41	154	1.8	16.0
11	65.6	202	0.80	32	157	2.2	9.2
12	84.6	217	0.83	34	158	1.8	9.5
13	54.4	190	0.79	36	160	1.6	14.3
14	95.4	226	0.83	38	159	1.2	16.4
15	70.7	203	0.85	40	157	1.4	12.6
16	79.1	211	0.84	35	153	1.5	9.2
17	66.4	199	0.84				10.2
13	79.3	206	0.91				11.2
19	122.7	248	0.80				11.8
20	71.3	212	0.75				15.1
21	63.1	197	0.83				14.4
22	53.2	181	0.90				10.6
23	65.6	199	0.83				8.7
24	59.0	194	0.81				8.8
25	43.8	174	0.83				7.3
26	66.1	200	0.83				7.2
27	81.7	218	0.79				6.3
28	65.1	198	0.84				9.0
29	66.0	203	0.79				18.5
30	59.3	197	0.78				8.4
	70.1+18.2	203+16	0.82+0.05	36+3	158+3	1.6+0.4	10.8+3.2

APPENDIX B

The Incidence of *R. salmoninarum* in Individual Steelhead Trout Prior to Release

Group 1 Pond 28 04-20-83

1. 0	11. 0	21. 0
2. 0	12. +1	22. 0
3. 0	13. 0	23. 0
4. 0	14. 0	24. 0
5. 0	15. 0	25. 0
6. 0	16. 0	26. 0
7. 0	17. 0	27. 0
a. 0	18. 0	28. 0
9. 0	19. +1	29. +1
10. 0	20. 0	30. 0

+1 = 3-30 (10.0%)

Group 2 Pond 40 04-29-83

1. 0	11. 0	**21. 0**
2. 0	12. 0	22. +1
3. 0	13. 0	23. 0
4. 0	14. 0	24. 0
5. 0	15. 0	25. 0
6. 0	16. +1	26. 0
7. 0	17. 0	27. 0
8. 0	18. +1	28. 0
9. 0	19. +1	29. 0
10. 0	20. 0	30. 0

+1 = 4/30 (13.3%)

Group 3 **Pond 36** 05-02-83

1. 0	11. +1	21. +1
2. 0	12. 0	22. 0
3. 0	13. 0	23. 0
4. 0	14. 0	24. 0
5. 0	15. 0	25. 0
6. 0	16. 0	26. 0
7. 0	17. 0	27. 0
8. 0	18. 0	28. 0
9. 0	19. 0	29. 0
10. +1	20. 0	30. 0

+1 ▫ 3-30 (10.0%)

Group 4 **Pond 34** 05-19-83

1. 0	21. 0	41. 0
2. 0	22. 0	42. 0
3. 0.	23. 0	43. +1
4. +1	24. +1	44. 0
5. 0	25. 0	45. 0,
6. 0	26. +1	46. 0
7.. 0	27. 0	47. 0
8. 0.	28. 0	4%. 0
9. +1	29. 0	49. 0
10. 0	30. 0	50. 0
11. 0	31. 0	51; 0
12. 0	32. 0	52. 0
13. 0	33. 0	53. 0
14. 0	34. 0	54. 0
15. 0	35. 0	55. 0
16. 0	36. 0	56. 0
17. 0	37. +1	57. 0
18. +1	3%. 0	58. 0
19. 0	39. 0	59. +1
20. 0	40. 0	60. 0

+1 = 8-60 (13.3%)

Group 5 Pond 30 04-20-83

1. 0	11. 0	21. 0
2. +1	**12. 0**	22.′ 0
3. 0	13. 0′	23:′ 0
4. 0	14. 0	24. 0
5. 0	15. +1	25. 0
6. 0	**16. 0**	26: 0
7. 0	171 0	27. 0
8. 0	18. 0″	2%. +1
9. +1	191 0	29. 0
10. 0	20. 0′	30. +1

+1 = 5/30 (16.7%)

Group 6 Pond 32 04-18-83

1. +1	11. 0	21. 0
2. +1	**12. 0**	22. 0
3. 0	13. 0	23. +1
4. 0	14. 0	24; 0
5. 0	15. 0	25. 0
6. 0	16. 0	26.′ 0
7. 0	i7. 0	27. 0
8. +1	18. 0	2%. 0
9. 0	19. 0	29. 0
10. 0	20. 0	30. 0

+1 = 4/30 (13.3%)

Group 7 **Pond 42** 05-02-83

1. 0	11. 0	21. 0
2. 0	12. 0	22. 0
3. 0	13. 0	23. 0
4. 0	14. 0	24. 0
5. 0	15. 0	25. 0
6. 0	16. 0	26. +1
7. +1	17. 0	27. 0
8. 0	18. +1	2%. 0
9. 0	19. 0	29. +1
10. 0	20. 0	30. 0

+1 = 4/30 (13.3%)

Group 8 **Pond 3%** 05-18-83

1. 0	11. 0	21. 0
2. 0	12. 0	22. 0
3. 0	13. +1	23. 0
4. 0	14. 0	24. 0
5. 0	15. 0	25. 0
6. 0	16. 0	26. 0
7. 0	17. 0	27. 0
8. 0	18. 0	2%. 0
9. 0	19. 0	29. 0
10. +1	20. 0	30. 0

+1 = 2/30 (6.7%)

APPENDIX C

Summary of Fish Health Examinations by Joseph C. Lientz

NMFS - 1983

Fish Health Exams

01-18-83 - Pre-mark exams

STT from all groups appeared to be in good health. Only light parasite loads of Gyrodactylus, Epistylis, and *Ichthyopthirius* were noted. Light to moderate fin erosion was observed. Some debris was noted in the gills but stress was not apparent.

03-02-83 - Pre-release exams

STT appear to be in good condition. Light parasite loads were observed. Dorsal fin erosion was more apparent. Gills showing more swelling and more obvious extension beyond the opercle. Short rod bacteria were noted and more debris was present.

03-18-83

Same as 03-02-83, but moderate to heavy dorsal erosion and gill swelling noted. More external changes of smoltification being observed.

04-04-83

Fish look good. No stresses indicated and very light parasite loads observed.

04-19-83

Fish in very good condition. No stresses.

04-29-83

Still very good. No stresses.

05-24-83

Fish with light external parasite loads (Gyrodactylus and Epistylis). Fins - dorsal erosion approximately 25 percent (moderate); gills - good. Smolt appearance.

Throughout the rearing period January 1983 through May 1983 the steelhead in the marked groups appeared to be in good health. No undue stress conditions were noted. There was an indication that the parasite load was reduced, gill condition improved and overall health improved with the lower temperatures after 04-04-83. It would again appear that these are some of the better STT produced in the history of Dworshak NFH.

APPENDIX D

Histological observations in select tissues of 1983 steelhead trout smolts reared at the Dworshak National Fish Hatchery,

by

Charlie E. Smith

and

John K. Morrison

HISTOLOGICAL OBSERVATIONS IN SELECT TISSUES OF 1983 STEELHEAD TROUT SMOLTS REARED AT THE DWORSHAK NATIONAL FISH HATCHERY

BY Charlie E. Smith & John K. Morrison, USF&WS, Bozeman Fish Cultural Development Center, Bozeman, Montana 59715

INTRODUCTION

The following report was prepared as part of an overall fish health examination to determine the well being of select groups of marked steelhead trout smolts reared at the Dworshak National Fish Hatchery during 1982-1983.

OBJECTIVE

The objective of this study was, by use of histological technique, to determine the condition of select tissues of steelhead trout smolts prior to their release from the Dworshak National Fish Hatchery.

METHODS

A histological examination of gills, kidneys, liver and nasal epithelium was conducted on 150 steelhead trout sampled during late April -early May (4/20,4/29,5/2 & 5/4) and 90 smolts collected in mid and late May (5/19 & 5/24) 1983.

Tissues were dissected from anesthetized fish and preserved in Bouin's fixative by Dworshak personnel. Samples were then sent to the Bozeman FCDC where they were processed for histological examination. Paraffin sections were cut at 5 ~m and stained with hematoxy1in and eosin-phloxine.

RESULTS

Gills

In general gills of the majority of smolts collected during late April -early May showed considerable hypertrophy (swelling) of lamellar epithelium (Fig 1) as well as mild diffuse necrosis of epithelium covering gill lamellae (Fig 2). Scattered fusion of some gill lamellae was also apparent, but was considered to be mild as were focal areas of edema and

inflammation located at the based of lamellae in a few fish: Seperation of gill lamellar epithelium from'underlying basement membrane was apparent in the majority of fish. Most of 'this, however, appeared to be artifact. Neither parasitic nor bacterial infections were observed in any of the fish.

Gills from smolts collected in mid-late May appeared to be in extremely good condition (Figs 3 & 4). Occasionally, fusion and clubbing of lamellae at the tips of some filaments was seen (Fig 5), but this was the exception rather than the rule.

Nasal *epithelium*

Considerable edema and mild diffuse necrosis of nasal:, sensory epithelial cells were a common finding in a large number of fish sampled in late April early May (Fig 6). In addition, copious amounts of mucus was being secreted by increased numbers of goblet (mucus secreting) cells in some of the smolts. Sloughed necrotic cells could sometimes be seen in the secreted mucus (Fig 7).

Nasal epithelium of smolts sampled in mid and late May was generally in good condition (Fig 8) and other than occasional:, focal areas of edema, none of the other changes mentioned above were apparent.

Livers

Liver tissue from all of the fish examined was essentially normal. There was very little cytoplasmic vacuolation 'in hepatocytes so typical of what is normally seen in hatchery fish and indicative primarily of reduced glycogen storage. This, however, may be normal for smolting steelhead.

Kidneys

Kidneys from all fish sampled were also essentially normal,. There was some mild swelling of kidney tubule epithelium and occasionally, hydropic vacuolation. Such 'changes, were very mild and only noted occasionally.

CONCLUSION

Based upon histological examination of gills and nasal epithelium of fish examined in later April - early May one canassumethat these fish were not healthy. The fact that tissues from fish sampled in mid to late May were normal may be related to the management practice of switching from reused water to raw water with a reduced temperature. This inturn reduces the metabolic loading of the hatchery thereby reducing feeding rates and metabolite production, both of which may aid in repair of damaged tissues.

The fungus infections noted in nasal capsules of downstream migrants in the past may have been due to the release of smolts having similar degenerative changes in nasal epithelium that have been demonstrated in this report. Such changes, along with physiological and environmental stresses would make the smolts more susceptible to fungal infection.

LEGEND TO FIGURES

Figure 1. Gill section from smolt collected 4/20/83 showing hypertrophy (swelling) of gill lamellar epithelium,. X 1100.

Figure 2. Hypertrophy and mild diffuse necrosis (arrows) of gill epithelium of fish sampled 4/20/83, X 1100.

Figure 3. Section of normal gill from smolt collected 5/24/83, X 175.

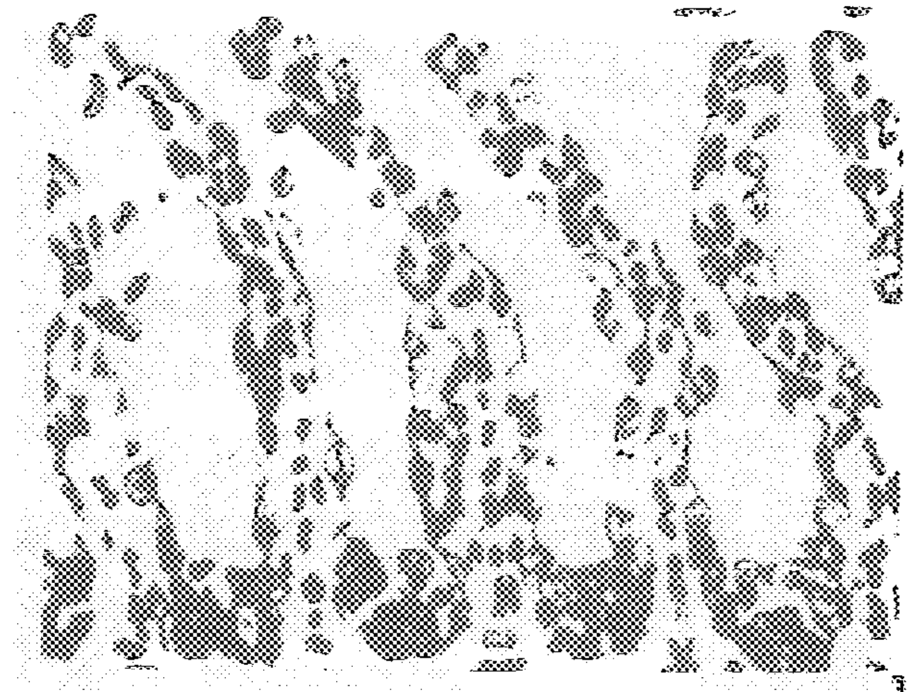
Figure 4. High power view of some gill lamellae shown in Figure 3, x 1100.

Figure 5. Fusion and clubbing of gill lamellae at tip of filaments from smolt collected 5/19/83, X 175.

Figure 6. Focal areas of edema with some necrosis (arrows) in nasal epithelium of smolt collected 4/29/83, X 450.

Figure 7. Nasal epithelium of smolt collected 5/2/83. Note necrotic epithelium (arrow) being sloughed into surrounding area containing mucus, X 450.

Figure 8. Normal nasal epithelium representative of that of smolt collected 5/24/83, X 450.



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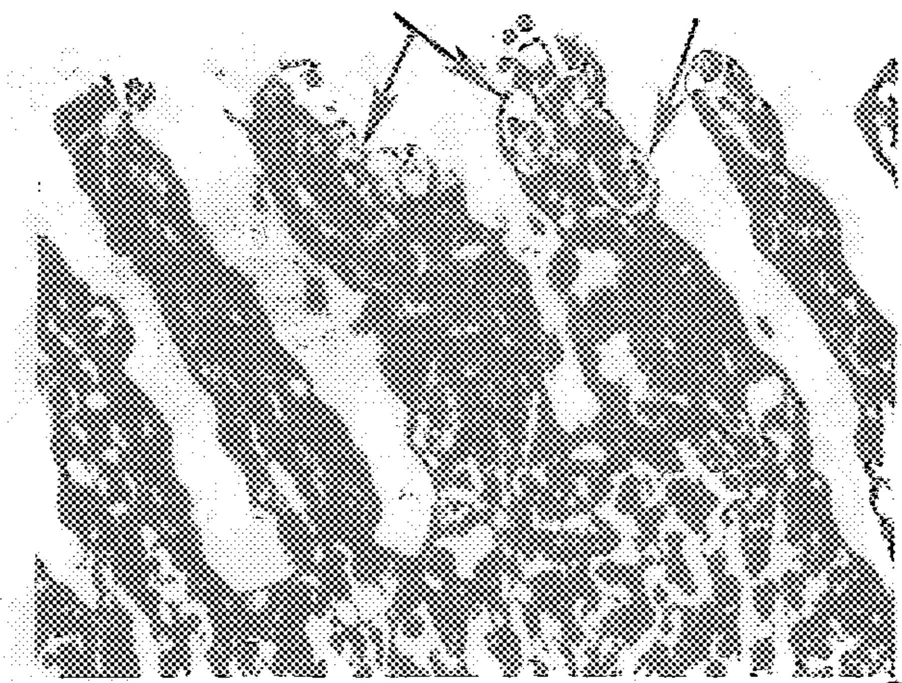

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(3)

(4)

5

6

7

8

APPENDIX B

Expenditure Information

Expenditure Information

A. Summary of expenditures:

1.	Labor	$23.8~	
2.	Travel of persons	4.2	
3.	Transportation of things	8.2	
4.	Rent, communications, and utilities	0.1	
5.	Printing and reproduction	0.0	
6.	Contract services	18.6	
7.	Supplies, materials, and equipment	7.8	
8.	SLUC	0.7	
9.	**NOAA** and DOC overhead	9.7	
	TOTAL	——	$73.1K

B. Major property items:

1. **None**